"HIGH FREQUENCIES COMPLEX PERMITTIVITY AND THERMODYNAMIC STUDIES OF CELLULOSE"

Synopsis

Submitted to the

Swami Ramanand Teerth Marathwada University, Nanded.

Research proposal submitted
In partial fulfillment of registration to
Ph.D. Program

In the subject of
PHYSICS

Under the faculty of Science & Technology

By

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Abstract of proposed work plan/problem

"HIGH FREQUENCIES COMPLEX PERMITTIVITY AND THERMODYNAMIC STUDIES OF CELLULOSE"

1. Introduction

Cellulose is one of the most abundant of naturally occurring polymers and is the most common organic compound on Earth. About 30% of all plant matter is cellulose. In 1838, French chemist Anselme Payen was able to isolate cellulose from a plant matter. [1] He also identified the chemical formula of cellulose: $(C_6H_{10}O_5)_n$, where n refers to the degree of polymerization. Cellulose is produced naturally by other forms of organisms aside from plants. It is found to be produced by certain bacteria, protists, algae, and animals (e.g. tunicates). Cellulose itself and its derivatives are also of great industrial importance. However, the regularity of cellulose chain and extensive inter- and intramolecular H-bonding between hydroxy groups cause cellulose to be a tightly-packed crystalline material. As a result, it is insoluble, even in the H-bonding solvents. Although cellulose is a linear polymer, it is infusible, and decomposition occurs before a sufficient number of hydrogen bonds are broken.' Thus, cellulose can not be processed either in melt or in solution. Despite this difficulty, several cellulose derivatives with less H-bonding have been developed which are processable and are of commercial interest. Most of these cellulose derivatives are chemically modified from the original cellulose in heterogeneous reaction mixtures. Cellulose is the major framework component that provides strength, stiffness, and structural stability for plant fibers. It differs in some respect from other polysaccharides produced by plants because its molecular chain is linear and long.

The force that holds atoms together within the molecules is called intermolecular force. These intermolecular forces play a vital role in the formation of mixture. A solution is formed

when one substance dissolves in to another substance .A solution is a homogeneous mixture of two entities namely called as solute and solvent. The solute is the substance that is being dissolved, while the solvent is the dissolving medium. Solutions can be formed with many different types and forms of solute and solvents. The simplicity with which solute molecules take the position of solvent molecules depends on the relative potential of three types of interactions; Solvent - solvent, Solute – solute and Solvent– solute. The solution contains molecules with electropositive hydrogen with electronegative atom (like nitrogen, oxygen, sulfur, or fluorine), the properties of the solution changes extremely due to hydrogen bonding [1]. Hydrogen bonds may form between similar molecules or in between different molecules. To study the interaction between solute-solvent, Spectroscopic techniques has been used. Spectroscopy is the science concerned with an interaction of radiation with matter. Spectroscopy technique is very useful to collect the information like structure, chemical composition about any substance. Depending upon the various parameters like size, shape and nature of the substance there are various types of spectroscopic techniques. Dielectric relaxation spectroscopy is the one of them which gives the information about mechanism of dielectric materials. Dielectrics are insulators which can be used to store electrical energy. When such substances are placed in an external field, their positive and negative charges get displaced in an opposite direction and the molecules develop a net dipole moment. This is called polarization of the material and such materials are called dielectrics. When electric field is applied across the dielectric material it gets polarized and electric field persists within them. Depending upon the strength of applied electric field, molecular structure and bonding nature, the molecules get oriented in parallel or anti-parallel directions. There are enmities authors who contribute on study of dielectric and molecular properties [2-5].

2. Literature Review and Development in the Subject(previous work done in the relevant area)

Dielectric relaxation spectroscopy is one of the most popular spectroscopy having frequency range from 10^{-4} Hz to 10^{12}Hz. So this spectroscopy is known as broadband dielectric spectroscopy. This dielectric relaxation spectroscopy has very sensitive relaxation process for an extremely wide range of time i.e. 10^{5} – 10^{-12} sec. Dielectric spectroscopy is used to understand the various terms like interaction between solute –solvent, charge distribution, orientation of molecules [6-9]. Considerable experimental studies have been done on the dielectric relaxation behavior in polar systems to understand the molecular structure and dynamics of polar or non-polar molecules. Over the past few years, extensive experimental and theoretical studies concerning the microwave dielectric relaxation of Cellulose and water systems have been reported [5-14]. Present work is devoted to study Complex permittivity and thermody parameters of Celluloses.

3. Objective of research/Proposed Hypothesis:

The main objective of the present work is to study

(i) Measurement of High frequency complex permittivity of Cellulose

(ii) Determine Thermodynamic from dielectric relaxation spectroscopy technique.

(iii) To determine the following parameters.

- To determine permittivity and loss of Celluloses in the frequency range from 10 MHz to 50 GHz.
- To determine Static dielectric constant and relaxation time.
- To Investigate molecular interactions in the Cellulose in different solvents

4. Methodology to be adopted:

Dielectric relaxation spectroscopy will be used for the measurement of complex permittivity. The Tektronix model no. DSA8300 Digital Serial Analyzer sampling mainframe along with the sampling module will be used for the time domain reflectometery (TDR). Figure 1 shows experimental setup for TDR. A repetitive fast rising 250mV voltage pulse of 200 KHz with 12ps incident and 15ps reflected rise time was fed through coaxial line system of impedance 50 ohm. Sampling oscilloscope monitors changes in step pulse after reflection from the end of Transmission coaxial line.

5. Importance of study/society application

Cellulose is available in different forms in market with very different Mechanical and pharmaceutical properties. Cellophane has several applications in pharmaceutical packaging due to its suitable characteristics such as good compatibility, durability, transparency and elasticity.

- **International/National status**: The following scientists are actively doing research in this field at international/National level:

1. P.K. KADABA, University of Kentucky Lexington, U.S.A..
2. F. Flueckinger , State University of New York,
3. F.Frenzel, University of Kentucky Lexington, U.S.A..
4. R.J. Sengwa, Jodhpur, JNV University, Jodhpur(RS).
5. Ranna V A Department of Physics, Gujrat University Ahemdabad ((Gujrat)

- **Significance of the study:**

The Complex permittivity measurements of Biopolymers using a Time Domain Reflectometry (TDR) make an immense impact on the fundamental study. The present study is devoted to complex permittivity of Cellulose using dielectric relaxation technique from 10MHz to 50GHz. From dielectric relaxation parameters; one can understand orientation of electric dipole and Polarization of molecules.

6. Proposed work plan/Formulation and structure of study:

First Year:

(i) Literature survey related to the Thesis topic

(ii) Course Work as per university syllabus

(iii) Literature Review system to be studied.

Second Year:

(i) Measurement and Training for Dielectric and spectroscopic Technique and analysis of dielectric data

(ii) Extract the dielectric parameters

Third year:

(i) Experimental data will be analysed

(ii) Present data in International/National Conferences

(iii) published in different International/National Journals.

(iv) Published experimental data in the peer Reviewed Journals

(v) Writing Thesis and submit to University.

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20. MU-SHIH LIN* and CHUNC-SONG HUANC "Syntheses and Characterizations of Allyl Cellulose and Glycidyl Cellulose"

Research Student	Research Guide
(SAKNURE SHANKAR HANMANTRAO)	***(Prof. Kumbharkhane A.C.)***